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UNITED STATES ENTOMOLOGICAL COMMISSION.

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BULLETIN NO. 5.

THE CHINCH-BUG.

ITS HISTORY, CHARACTERS, AND HABITS, AND THE MEANS OF DESTROYING IT OR COUNTERACTING ITS INJURIES.

I

By CYRUS THOMAS, Ph. D.

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Washington, D. C.

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LETTER OF TRANSMITTAL.

CARBONDALE, ILL., *December* 6, 1879.

DEAR SIR: I herewith submit to the Commission for publication the manuscript of the Bulletin I have prepared, according to the direction of the Commission, on the history, description, and habits of the chinch-bug, and the best means of destroying it or preventing its injuries.

Very respectfully,

CYRUS THOMAS.

Prof. C. V. RILEY,

Chief of United States Entomological Commission.

THE CHINCH-BUG.

The chinch-bug (*Blissus leucopterus* Say) is unquestionably one of the most formidable insect pests with which the farmers within the wheat-producing area of the United States have to contend. Although not exceeding a grain of wheat in size, rather slow motioned, and possessing no other weapon of destruction than its tiny slender beak, yet the species is enabled to make up by number for the lack of individual capacity for destruction.

The locusts of the west are the only creatures of this class "which exist within the bounds of our national domain, whose multiplication causes more sweeping destruction than does that of this diminutive and seemingly insignificant insect." In the territory east of the Mississippi it is without a rival.

Mr. Walsh estimated the loss from the ravages of this insect in Illinois alone, in 1850, at $4,000,000, an average of $4.70 to every man, woman, and child then living in the State.

Dr. Shimer says that it "attained the maximum of its development in the summer of 1864, in the extensive wheat and corn fields of the valley of the Mississippi, and in that single year three-fourths of the wheat and one-half of the corn crop were destroyed throughout many extensive districts, comprising almost the entire Northwest, with an estimated loss of more than $100,000,000 in the currency that then prevailed."

Mr. Thomas, in his second report as State entomologist of Illinois, remarks as follows, in reference to the loss occasioned by them in 1871: "I find no complaints of damage recorded in 1870, but as the summer was dry over a large area, and they appeared in immense numbers in 1871, it is more than probable that they began to increase in the latter half of the season."

As Dr. Le Baron has noticed somewhat fully in his second report their operations in 1871, it would be unnecessary for me to do more than advert to it, were it not for the fact that this second report does not appear to have been generally distributed and is rarely seen. The following quotation will suffice to show the extent and severity of this visitation:

"Some idea of the loss caused by the depredations of this insect, in this and neighboring States, may be realized when we learn that over a belt of territory 100 miles wide, commencing in the western part of Indiana, and extending more than 400 miles west, embracing an area of more than 40,000 square miles, the great staple of spring wheat was reduced to not more than a quarter of an average crop, and in many places wholly destroyed; and that over the same territory barley was

less than half a crop, and oats not more than three-quarters of their usual amount.

"The center of this belt appears to have been a little north of the center of the State, being about on a line with the junction of Iowa and Missouri, and taking in a corresponding part of Southern Iowa and Nebraska and of Northern Missouri and Kansas. South of this belt winter wheat takes the place of spring wheat and barley, and the chinch-bugs, though present in considerable numbers, ceased to commit any very serious damage. North of this belt, also, notwithstanding that spring wheat constitutes a leading crop, the bugs became gradually less numerous, and a tolerable crop of this grain was harvested. And yet all through Northern Illinois and the southern part of Wisconsin, these insects were numerous enough to damage the crop to some extent, and to excite the most serious apprehensions for the succeeding year.

"In order to obtain as correct an idea as possible of the amount of loss sustained by the agriculturist from the depredations of this insect the past year (1871), both in this and the Northwestern States, I have made the following calculations, based upon the statistics of the Department of Agriculture, with a reasonable estimate of the proportional damage caused by this insect to those crops upon which they depredate. All such calculations must necessarily be only approximately correct, and very loose and extravagant conjectures have sometimes been indulged in upon the loss caused by chinch-bugs in former seasons of their prevalence. It has been my intention to keep within reasonable bounds, and, by giving the figures in the case, I give others the opportunity to review my estimates.

"Taking the returns of the Department of Agriculture, for the years 1869 and 1870, for our guide, we may assume the present annual yield of wheat in the State of Illinois to be 30,000,000 of bushels, of oats 40,000,000, and of barley 3,000,000.

"The area seriously ravaged by these insects comprised, as we have above stated, about the middle third of the State. This section would bear its full proportional third of the wheat and oats, and at least one-half of the barley raised in the whole State. This would give as the product of that part of the State ravaged by chinch-bugs 10,000,000 bushels of wheat, upwards of 13,300,000 bushels of oats, and 1,000,000 bushels of barley. The proportion of these crops destroyed by chinch-bugs we have put at three-quarters of the wheat, one-half of the barley, and one-quarter of the oats. This will give as the amounts actually destroyed by these insects, 7,500,000 bushels of wheat, 500,000 bushels of barley, and in round numbers, 3,300,000 bushels of oats.

"If we make a cash estimate of this loss, by putting the price of wheat at $1 a bushel, barley at 50 cents, and oats at 25 cents, we shall have an aggregate loss of upwards of $8,500,000 in the central third of the State of Illinois.

"In this estimate we have made no account of the injury done to corn throughout the State, nor of the damage to small grains north of the central belt. Here the calculation becomes much more indefinite, but I believe it will be generally admitted to be a low estimate if we add, for this purpose, one-quarter part to the above aggregate of loss. This will make the total loss caused by chinch-bugs in the State of Illinois, in the year 1871, upwards of $10,500,000. If we assume an equal amount of loss for the two States of Iowa and Missouri combined, and another equal amount for the four States of Indiana, Kansas, Nebraska, and Wisconsin, we shall have a total loss in one year, in the Northwestern States, of upwards of $30,000,000 from this one species of insect."

The loss in 1874 was probably equal to that in 1864; and I think actually greater.

Professor Riley made a careful estimate by counties of the loss in Missouri, which he found to aggregate the large sum of $19,000,000. I made careful estimates of loss on corn alone in Illinois by this insect in 1874. These estimates were based on different data, so as to form checks, the one upon the other, and the loss by drought was eliminated. The result showed a loss of about $20,000,000 on this single cereal. The entire loss to the State that year by the operations of this pernicious insect were not less than $30,000,000, or $11.50 to each inhabitant.

If the loss in the two States, Missouri and Illinois, amounted to nearly $50,000,000, it is not probable that the entire loss to the nation by this diminutive insect in 1874 fell any short of $100,000,000.

As the species appears to have a maximum of development about every five years, the foregoing estimates render it probable that the annual loss to the nation by its operations averages $20,000,000

Is it possible to prevent this great drain upon the agricultural industry of our country, or to materially lessen it? To obtain, if possible, an affirmative answer to this inquiry is the object of the Commission. That this loss to a large extent may be prevented is confidently believed; but to do this it is first necessary to have the farmers of our country fully informed in reference to all that is known respecting the characteristics, life-history, and habits of the species; also in reference to the various remedial measures which have been tried or suggested, and what the result has been so far as they have been tested. It is also necessary to inform them fully in reference to what co-operation is necessary, the plans that have been tried, and the result.

Our object, therefore, in presenting this bulletin is to give a brief *résumé* of what has been ascertained up to the present time in regard to the history and habits of the chinch-bug, and what remedies have heretofore been tried or suggested. This is done with the hope that the farmers throughout our country will aid us in this work, which the liberality of our national Congress has ordered for the benefit of the agricultural interests of the nation, and by testing practically the remedies suggested or others that may suggest themselves, and, informing us of the results, enable us to determine the best possible means of counteracting this pest.

The early history of its operations in our country is briefly given by Dr. Fitch in his second report on the Noxious Insects of New York, from which we extract the following:

"It was just at the close of our Revolutionary struggle, or about the year 1783, that this bug was first noticed as a depredator upon wheat, in the interior of North Carolina. It was at first supposed to be identical with the Hessian fly, which at this time was making such destruction in wheat crops on Long Island and in New Jersey. Two years before this, the British army, accompanied by a detachment of its German auxiliaries, had marched through North Carolina, and the battle

of Guilford was fought. Mr. J. W. Jeffreys states (Albany Cultivator, first series, vol. vi, p. 201) that an aged and highly respectable citizen of Orange County, North Carolina, informed him that it was 'immediately after this event that the Hessian fly or Hessian bug destroyed their crops of wheat; and they believed and do believe to this day (1839) that those soldiers left the flies or bugs as they passed through the country.' The insects continued to increase and spread through the Carolinas and Virginia for several years. In 1785 the fields in North Carolina were so overrun with them as to threaten a total destruction of the grain (Webster on Pestilence, vol. i, p. 279). And at length the crops were so destroyed in some districts that they were obliged to wholly abandon the sowing of wheat. It was four or five years that they continued so numerous at this time.

"The only particular account which was published of the insect and its habits at this period, of which we have any knowledge, appeared in London, in Young's Annals of Agriculture, vol. xi, p. 471. It is from this notice of it, Kirby and Spence state, that they derive the information given in their Introduction to Entomology (p. 127, American edition), which is as follows: 'America suffers also in its wheat and maize from the attack of an insect, which, for what reason I know not, is called the chintz-bug fly. It appears to be apterous, and is said in scent and color to resemble the bed-bug. They travel in immense columns from field to field, like locusts, destroying everything as they proceed; but their injuries are confined to the States south of the fortieth degree of north latitude. From this account the depredator here noticed should belong to the tribe *Geocorisæ* Latreille; but it seems very difficult to conceive how an insect that lives by suction, and has no mandibles, could destroy these plants so totally.'

"About the year 1809, we are informed by Mr. Jeffreys that the chinch-bug again became so destructive in North Carolina that in Orange County the farmers had to abandon the sowing of wheat for two years, and according to his statement the insects were subdued thereby. At various other times, of which we have no record, it has undoubtedly been abundant in that and the adjacent States, that section of country appearing to be its headquarters.

"In 1839, we have accounts of its having again become excessively numerous and destructive in Virginia and the Carolinas.

"The bug had now become so numerous in Carolina and Virginia that, with its continued increase in 1840, the total destruction of their crops appeared inevitable. The prospect was so alarming that Sidney Weller, of Brinkleyville, Halifax County, North Carolina, and others in his neighborhood, united in the spring of 1840 in pledging a handsome sum as a prize for some feasible method to arrest the career of this depredator. But at this juncture Providence interfered to accomplish what no human agency could have effected. Instead of being dry, like the two or three preceding years, the summer of 1840 proved to be of an opposite character, and the ravages of this insect were at once suppressed.

"It was about this period that the chinch-bug began to be noticed along the Upper Mississippi and through the northern parts of Illinois. It made its appearance there simultaneously with the establishment of the Mormons at Nauvoo (1840–1844), and many ignorant people firmly believed they were introduced there by these strange religionists, and 'Mormon lice' became the name by which they were currently designated through that district."

The history of its operations in Illinois from the time it was first observed, in 1840, up to 1877 is given by the writer quite fully in his

Second Report on the Noxious and Beneficial Insects of Illinois. This may be briefly summarized as follows:

The first notice of it in the State was in 1840, when it appeared in the northwestern portion, near the Mississippi, and in Tazewell County. There is also reason to believe it appeared this or the following year in Saint Clair County. In 1844 it was somewhat injurious in Sangamon and some other sections. In 1845 it did extensive damage in Knox, Tazewell, Will, and some other counties. In 1846 it was observed in Cass County. In 1847 it appeared in Lyons County, Iowa. In 1848 it was observed in Lake County, Indiana, but there is no mention of it that I can find in Illinois in 1847, 1848, or 1849. But it is more than probable it began to develope in 1849, as it appeared in destructive numbers in 1850 over a large portion of Northern Illinois. Formidable numbers appeared in Illinois and the adjacent portions of Indiana and Wisconsin in 1854 and 1855, especially the latter year. This, according to Mr. Williams, of Geneva, Wis., was its first appearance in that State, coming from the south. In 1855 it did considerable injury in Mercer and DeKalb Counties and some portions of Southern Illinois. In 1857 and 1858 it was observed in limited sections of the State. In 1861 and 1862 it was reported by Dr. Shimer as doing considerable injury in the northwestern portion of the State. In 1864 the crops in Iowa and adjoining sections of Illinois suffered largely from its attacks, as did also other portions of the Northwest. It again made its appearance in Illinois in 1865, but the season being wet the insects were destroyed. In 1868 and 1869 it appeared in limited numbers in the southern portion of the State, but its development was cut short by the wet weather. The year 1871 was marked by its appearance in vast numbers over the Northwestern States; and, as heretofore stated, 1874 was also another noted chinch-bug year.

The following brief notice of its history in other sections is given here, but this we expect to make more complete in our second report.

From Professor Riley's seventh report as State Entomologist of Missouri, we learn that it appeared in that State as early as 1836; that it was more or less injurious in certain sections in 1854, 1855, 1856, 1857, and 1859; that in 1866 it was quite destructive, as also in 1870–'71; but 1874 was the year in which it was most injurious in this State.

From a communication received from Mr. J. H. Wissler, of Lockville, N. C., we learn this insect was very destructive in that State about 1837, a date not mentioned by Dr. Fitch. The same writer also states that "it was very troublesome about twenty years ago (1859)," at which time we learn by a letter from Mr. E. A. McWhorter, of Camden County, Georgia, that it injured the rice crop in that county, the only certain notice we have of its appearance in that State.

Mr. W. J. Ross, of Stanley County, North Carolina, writes us that "these insects were abundant and did much damage in that county in 1837 and 1845."

It appears from Dr. Fitch's second report that they were so numerous in Virginia and North Carolina in 1856, as to spread a general alarm from the mountains to the seaboard.

NAMES AND DESCRIPTION.

The chinch-bug is a small insect less than one-fourth of an inch long, its length usually not exceeding three-twentieths of an inch; its width something less than one half its length; rounded on the underside and flat above; of a coal-black color, with white wings which have a triangular, black dot on their outer margins. It belongs to the order HEMIPTERA and sub-order *Heteroptera*, to which group also belong the common bed-bug, squash-bug, and other similar true bugs. This species, like all the rest belonging to the order, has the mouth prolonged into a slender, horny, jointed beak, usually turned unde the breast when not in use. With this instrument, and the slender needle-like setæ inclosed within it, they puncture the bark, leaves, and stems of plants, and suck out their juices. It is in this way the chinch-bug obtains its food. As it has no means of gnawing plants, and is so diminutive in size, it would appear to be incapable of inflicting any very serious injury on vegetation; but, as heretofore stated, what it lacks in individual capacity for inflicting injury is made up by the immense numbers which are occasionally developed. A myriad of tiny pumps incessantly drawing away the juices of a plant must in a short time cause it to decay and die.

Although, as we have seen, the insect was known long before 1831, yet it was not until that year that it was scientifically described by Mr. Say, who "took a single specimen on the Eastern Shore of Virginia." This description, under the name *Lygæus leucopterus*, was given in a small pamphlet on the *Heteropterous Hemiptera* of North America, published by Mr. Say at New Harmony, Ind., December, 1831, and is as follows:

"*Lygæus leucopterus.*—Blackish, hemelytra white with a black spot. Inhabits Virginia. Body long, blackish, with numerous hairs; antennæ rather short, hairs; second joint yellowish, longer than the third, ultimate joint longer than the second, thickest; thorax tinged with cinerous before, with the basal edge piceous; hemelytra (elytra) white, with a blackish oval spot on the lateral middle; rostrum and feet honey-yellow; thighs a little dilated. Length less than three-twentieths of an inch."

FIG. 1.

Chinch-bug. The line below shows the natural length.

Nineteen years afterwards Dr. Le Baron, not aware that the species had previously been described, named it *Rhyparochromus devastator*, and gave the following description in the Prairie Farmer of September, 1850:

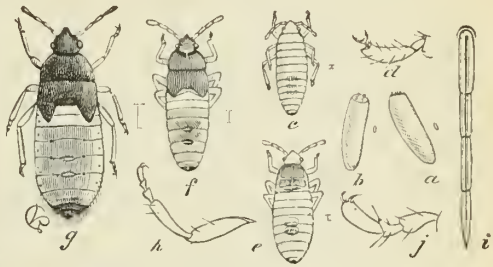
"Length $1\frac{2}{3}$ lines or three-twentieths of an inch. Body black, clothed with a very fine grayish down not distinctly visible to the naked eye; basal joint of the antennæ honey-yellow, second joint the same, tipped with black, third and fourth joints black; beak brown; wings and wing-cases white; the latter are black at their inser-

tion, and have near the middle two short, irregular black lines, and a conspicuous black marginal spot; legs dark honey-yellow, terminal joint of the feet and the claws black."

Numerous descriptions of the young or larva have been given, but that by Professor Riley in his seventh report is perhaps the most complete, and as it leaves nothing to add, being taken from fresh specimens and including the egg, I copy it here, together with his excellent figure of the preparatory stages:

"*Egg.*—Average length .03 inch, elongate-oval, the diameter scarcely one-fifth the length. The top squarely docked and surmounted with four small, rounded tubercles near the center. Color, when newly laid, pale or whitish, and translucent, acquiring with age the amber color, and finally showing the red parts of the embryo, and especially the eyes toward the tubercled end. The size increases some what after deposition, and will sometimes reach near .04 inch in length.

Fig. 2.



Chinch-bug, Larva, Pupa, and Egg. *a* and *b*, eggs; *c*, young larva; *d*, tarsus; *e*, larva after first molt; *f*, larva after second molt; *g*, pupa; *h*, leg; *i*, the beak or tubular mouth.

"*Larval stages.*—The newly hatched larva (Fig. 2, *c*) is pale yellow, with simply an orange stain on the middle of the three larger abdominal joints. The form scarcely differs from that of the mature bug, being but slightly more elongate; but the tarsi have but two joints (Fig. 2, *d*) and the head is relatively broader and more rounded, while the joints of the body are subequal, the prothoracic joint being but slightly longer than any of the rest. The red color soon pervades the whole body, except the first two abdominal joints, which remain yellowish, and the members, which remain pale. After the first moult (Fig. 2, *e*) the red is quite bright vermilion, contrasting strongly with the pale band across the middle of the body, the prothoracic joint [first behind the head] is relatively longer, and the metathoracic joint [third behind the head] shorter. The head and prothorax are dusky and coriaceous and two broad marks on the mesothorax [second joint behind the head], two smaller ones on the metathorax, two on the fourth and fifth abdominal sutures, and one at the tip of the abdomen are generally visible, but sometimes obsolete; the third and fourth joints of the antennæ are dusky, but the legs are still pale. After the second moult [Fig. 2, *f*] the head and thorax are quite dusky and the abdomen duller red, but the pale transverse band is still distinct; the wingpads become apparent, the members are more dusky, there is a dark red shade on the fourth and fifth abdominal joints, and ventrally a distinct circular dusky spot covering the last three joints.

Fig. 3.

Short-winged Chinch-bug.

"*Pupa.*—[Fig. 2, *g*]. In the pupa all the coriaceous parts are brown-black, the wing-pads extend almost across the two pale abdominal joints, which are now more dingy, while the general color of the abdomen is

dingy gray; the body above is slightly pubescent, the members are colored as in the mature bug, the three-jointed tarsus is foreshadowed, and the dark horny spots at the tip of the abdomen, both above and below, are larger."

The characters of the perfect insect are so fully given in the descriptions by Say and Dr. Le Baron, already quoted, that it is unnecessary for me to repeat them here. I may add that the antennæ, which are not described, are a little less than half the length of the body, composed of four joints, the last being the largest. Dr. Fitch has also pointed out the following varieties:

"*a*, *immarginatus*.—Basal margin of the thorax not edged with yellowish. Common.

"*b*, *dimidiatus*.—Basal half of the thorax deep velvety black, anterior half grayish. Common.

"*c*, *fulvivenosus*.—The stripes on the wing-covers yellow instead of black.

"*d*, *albivenosus*.—Wing-covers white, without any black marks except the marginal spot. A male.

"*e*, *apterus*.—Under or true wings wanting, wing-covers much shorter than the abdomen.

"*f*, *basalis*.—Basal joint of the antennæ dusky and darker than the second.

"*g*, *nigricornis*.—First two joints of the antennæ blackish.

"*h*, *femoratus*.—Legs pale livid yellow, the thighs tawny red. Common.

"*i*, *rufipedes*.—Legs dark tawny-red or reddish-brown."

Professor Riley adds another, *melanosus*, "in which the usual white of the wings is quite dusky and contains additional black marks at the base and toward the tips, and in which all the members and the body, except the rufous hind end of the thorax, are jet black."

It is but an act of justice to state that as early as 1845 (Prairie Farmer for October, 1845) Mr. J. Hadley gave the first brief description of the larval state; although brief and making no pretensions to scientific accuracy, yet the larval and pupal states are clearly indicated.

There is also occasionally seen in the northern sections a short-winged form of the perfect insect, such as is shown at Fig. 3.

The common name Chinch-bug is from the Spanish *chinche*, signifying bug. The name *chintz* and *chink bug* were formerly occasionally used. As special notice was first called to them in Illinois, in the section and about the time the Mormons came to Nauvoo, they were named "Mormon lice."

NUMBER OF BROODS AND HIBERNATION.

It was known soon after the insect became troublesome that there were more broods than one, some, as Mr. Hadley, supposing there were "five or six generations." It is a quite common opinion, and is held by many to the present day, that there are three broods. This belief arises very naturally from the fact that those which hibernate appear in the spring to deposit eggs; the perfect insects from these are counted as a

second brood, the fall brood being the third, according to this method of counting; but, as will be seen by careful observation, those which appear in the spring are the same ones seen late in the fall. Dr. Shimer observed in 1864 and 1865 that this species is two-brooded, but no account of his observations were published until 1867. In the mean time, Professor Riley published the fact in 1866 that they are but two-brooded in the northern part of Illinois. Subsequent observations have shown this to be the rule in the other parts of the State and throughout the Northwest. There is some evidence of an occasional third brood in the extreme southern part of the State and in Kentucky, but not sufficient to justify me in asserting it as a fact or to satisfy me of its correctness.

Insects may pass the winter as eggs, which is a very common method; as larvæ or young, which is rather unusual; as pupæ, which is a very common method in those orders where the pupa state is one of complete quiescence; and, lastly, they may pass the winter as perfect insects.

The last method is the one adopted by the Chinch-bug. When cold weather comes on, those of the fall brood leave the now dry and hardened corn-stalks and seek secure places in which to remain during the winter. Occasionally they take flight at this time, but usually they seek the most secure places which can be found in and immediately around the field. Any rubbish left in the field, if of a nature to meet their wants, is eagerly sought; corn-shocks, straw-piles, stumps, logs, and fence-rows are used as hiding-places; they even hide beneath the clods when no better places can be found. But many move into the forest, grove, or woodland, if either happens to be near at hand. I have found also that the line of bushes along a little branch traversing the field is a favorite resort. Sheds, barns, rail-fences, and stacks often furnish them with winter quarters.

During the winter they remain in a torpid or semi-torpid state, but are easily warmed into life and activity. As the cold weather becomes more and more severe they press deeper and deeper, if possible, into the inner recesses of their hiding-places. They prefer dry quarters if readily obtained.

Whether the males survive in equal numbers with the females is a point not ascertained, so far as I am aware, but I am of the opinion that the females are the more numerous.

Their time of coming forth in the spring depends upon the latitude and season. In a few instances in unusually early springs they have been seen as early as the middle or latter part of March in the southern end of this State; while, on the other hand, in the northern part of the State in a late spring they have delayed their appearance until late in May, and probably even until the first of June. Usually they come out during the month of April in the southern and central part of the State. But it must be admitted that there is but little testimony on this point, as but very few of our farmers pay any attention to insects except when

they become injurious or appear in immense masses. The chinch-bug, when flying, would scarcely be distinguished by the unpracticed eye from a gnat. On this account our correspondence, and the printed and manuscript notes we have examined, make far more frequent mention of the first appearance of the young than they do of the spring appearance of the hibernating brood.

In order to show the various hiding-places they select in which to hibernate, I quote the following notes from correspondents as found in my second report:

"When winter set in they went into winter quarters under corn-shocks, clods, rails, &c."

"I have never known them to winter in timothy or any tame hay; but if you want to raise an extra crop of bugs, leave a few bottoms of prairie-hay stacks and piles of corn-fodder and straw until June, and, my word for it, you will have them."

"Their winter quarters are old rail fences, corn-stalks, house-roofs, logs, leaves, &c."

In addition to these places, we may add that in timbered sections they frequently go to the woods and seek shelter under the leaves and in the crevices of the bark of trees, under loose bark, and even hide under stones. I have found them quite abundant in old stumps and old logs, and around fields which had been in corn during the summer previous. When no other hiding-place can be found they will seek shelter from the cold under clods of earth.

As the cold increases they will penetrate farther and farther into their recesses. They prefer comparatively dry situations, as moisture appears to be inimical to them, though in this stage of their existence it does not appear to be necessarily destructive of life as the following statement in my second report, given by a correspondent on whose veracity and intelligence I can rely, will show:

"They have been taken from ice, by thawing it, and when slightly warmed would manifest signs of life, crawling about as in spring. They thus appear to be able to endure cold or heat."

I have often taken them in winter inclosed in a covering of frost and to all appearances frozen stiff, yet when placed in a warm atmosphere for a time they would survive. The following statement by Dr. Henry Shimer, of Mount Carroll, Ill., in reference to their winter life, will be interesting in this connection:

"After the early autumn frosts they left their feeding-grounds, on foot, in search of winter quarters; none could be seen on the wing as at harvest time. For a winter retreat they resorted to any convenient shelter they might chance to find, as long grass, weeds, boards, pieces of wood, rails, fallen tree leaves, &c.

"In January, 1865, I next examined their condition; those that I found in the sheaths of the corn-leaves above the snow, and had been thus exposed during the previous severe weather—when for several successive days the thermometer was 15° to 20° below zero—were invariably found dead, without exception, and those beneath the snow were alive. This observation was made in the common farm corn-fields, as

they might be found anywhere all over the wide country, for in autumn the chinch-bugs remained in great numbers in the corn-husks and under the sheaths of the blades, as well as in other winter retreats. Upon various occasions, as the winter advanced, I brought in corn-husks filled with ice, inclosing the chinch-bugs in the crystallized element; when the ice was thawed they were able to run, apparently unaffected by that degree of cold. It is therefore proved that these insects possess vitality sufficient to withstand the effect of a temperature below the freezing-point, and perhaps below zero, as must have been their condition in these ice-bound husks; but when in the open air, exposed to the sweeping prairie winds, 15 or 20 degrees below zero, for a long time, they succumb to the cold.

"*March* 7, 1865.—The snow having cleared off from the ground, I examined the condition of a host of these chinch-bugs that had chosen for their winter covering cord-wood sticks lying on the ground, entirely surrounded by frost and ice; of these 20 per cent. were living; those that were more fortunate in their selection of winter quarters fared much better. From a single handful of leaves picked up at one grasp from beneath an apple tree, I obtained 355 living and 312 dead chinch-bugs; and of their lady bird enemies that had entered the same winter quarters with them, 50 were living and 10 dead. Of these chinch-bugs I placed a number in comfortable quarters in the house in a small pasteboard box—not in a stove room—together with some coleopterous insects casually gathered among the chinch-bugs; after one month I found the latter all dead and the former living.

"The entire month of March was rain, snow, thawing, freezing, alternately, seeming to be very uncomfortable for any living creature to remain out of doors with so poor a shelter and on top of the ground.

"April 1–6, I again made repeated examinations of these chinch-bugs in their winter quarters, and found about the same proportion of them living as noted on the 7th of March. At this time they wandered away on foot from their winter quarters."

THE FIRST BROOD.

Immediately after they come out of their winter quarters in the spring, which varies, according to latitude and the season, from the latter part of March to the middle of May, they pair. Dr. Shimer states in the article from which we have just quoted that he observed them at this time on the wing, which he appears to think is their usual method during the time of their amours, but observations made by myself and others do not confirm this opinion; on the contrary, they show it to be unusual.

After pairing, the females commence laying their eggs, and unfortunately for the farmer, nature appears to have made a special provision for them to adapt them to the vicissitudes of season, and even in reference to their method of oviposition. If compelled to deposit all their eggs at one time, an entire brood might be destroyed by a single drenching rain; but the female proceeds leisurely with her work, day by day depositing a few, those in her ovaries developing as necessity demands, the process being carried on for two, or even three, weeks. According to the observations of Dr. Shimer, the usual time occupied in this work is about twenty days, and the number deposited about 500.

As a general rule, the eggs deposited at this time are placed just below the surface of the soil on the roots, or on the stem near the surface. The moisture of the soil at the time probably has something to do with the position chosen, the higher being selected when it is damp, and the lower when it is dry; the condition as to compactness or hardness doubtless has also something to do with the position selected. Dr. Shimer remarks that he "found the chinch-bug eggs more abundant mostly on the roots and stalks beneath the ground, sometimes in loose clusters of a dozen or more. They were on the roots, where they crossed the numerous cracks in the ground; less frequently on the stem, at the surface of the ground." Sometimes, as before intimated, this is reversed, and they are more abundant on the stem near, or just beneath, the surface than on the roots.

Numerous observations show that the eggs are more liable to be affected by climatic influences than the perfect insects, and are sooner destroyed by heavy rains. The moisture has the effect of dissolving the substance by which they are attached to the stalks, and the water carries them down into the moist soil and destroys their vitality. The following statement by Professor Ross, in the communication before alluded to, is quite interesting in this connection. His letter is dated June 4, 1875:

"Within the last week we have had two heavy showers of rain. Before either of them fell I examined very carefully the eggs deposited about twelve or fifteen days ago. They were very abundant on nearly every stalk of wheat, always deposited within one or two inches of the ground, in the sheath close to the stalk. There were probably an average of fifty eggs on the stalk. This evening, four days after the first examination, with a good glass, magnifying twenty-five diameters, at hand, I examined the same field of wheat at the same place as my first examination. I found but few old bugs; some of the eggs had hatched out, but by far the greater number of eggs were washed down from their places, distorted in shape, sunken into the soil, and many decomposed; probably not more than one in ten of the first I saw had developed into a bug. I could easily tell the eggs that were destroyed. I examined many stalks on which I found no eggs. Abundant evidence is at hand in proof of their destruction in the egg state by rain."

The egg is at first of a pale dull whitish or testaceous color, but at length assumes a reddish color, from the changes transpiring within; the embryo can be seen as a red speck in the center through the transparent shell. When first hatched the young bug is red with a white stripe across it; afterwards it turns of a brownish or grayish-brown color. Soon after it is hatched it inserts its tiny beak into the plant on which it is situated and commences pumping out the juices on which the vigor and life of the plant depend. As their growth is rapid their molts are frequent; before reaching the perfect or winged state it passes through four of these changes, varying in color and markings after each. According to Mr. Riley's observations, "It is bright red, with a pale band across the middle of the body after the first; some-

what darker with the merest rudiments of wing-pads after the second; and quite brown with distinct wing pads, but with the pale transverse band still visible after the third." The entire process requires from five to seven weeks; according to Dr. Shimer's observations, from the time the egg is deposited until the imago appears is usually from fifty-seven to sixty days.

It is but a short time after they reach the perfect state—a few days only—before they pair, and the females deposit their eggs. The insects produced from these constitute the "fall" or "second brood," and pass through the same changes as those of the first brood. The perfect insects of this brood, as before stated, live through the winter. In the southern part of this State, at least, it is not an uncommon thing to find the pupæ wintering over; whether those caught in this condition acquire complete wings in the spring is a question I am as yet unable to answer. I have observed, as I think, a similar fact in reference to the corn *Aphis* (*Aphis maidis*); but in neither case have I had an opportunity of observing the final result.

MIGRATIONS.

Before the females of this brood deposit their eggs they leave their original quarters and migrate in search of a more abundant supply of food. When this movement takes place it appears to be a very general one, and not, as sometimes supposed, solely for the purpose of enjoying the season of their amours or for depositing eggs, though these may be and doubtless are often in part the cause of this movement. About this time the wheat becomes dry and hard, and no longer furnishes a supply of food; hence, they are necessarily forced to migrate or perish. Occasionally they take to flight, and this appears to be more common some years than others, depending to a great extent upon the state of the weather, and perhaps to a certain degree upon being the time of their amours, as suggested by Dr. Shimer. But the far more usual and almost universal method is by marching along the surface of the ground. There appears to be no uniformity in the direction taken; in fact, they sometimes scatter and go in different directions from the same field, but as a general thing the masses take one direction, which is towards the nearest field of corn, oats, or some other cereal or grass that is still in a succulent state. In those sections where corn is the chief or second crop it is generally attacked. As the number of stalks to a given area is much less than in the wheat-field the forces are concentrated, and each stalk of corn receives the bugs of perhaps a hundred wheat-stalks. When the insects are very numerous the effect is soon visible.

In these migrations the insects are by no means all matured; often the majority have not advanced beyond the pupa state, but the want of nourishment forces them to "go west" or in some other direction in search of food. In all such movements mature and immature individuals

will be observed. In some instances the numbers are so great that not only is the surface of the ground literally covered, but they are piled on each other. If disposed to fly, which is not often the case, it sometimes becomes necessary to protect the nostrils of the horses at work in the fields. Those who have never witnessed a movement of this kind have a very faint idea of the immense numbers of individuals there are, and the vast army of insects a single field of wheat has been feeding. Simply as a matter of curiosity I have made a calculation in order to ascertain the number of individuals on a given area. Suppose it to be the side of a field 40 rods long from which they were issuing and that they covered the ground completely, but singly, for a width of one rod, this would give at least 175,000,000 individuals. If the cornfield attacked was 40 rods long, this would give about 17,000 individuals to each hill for a depth of fifty rows.

The following quotations will serve to illustrate this habit:

"When the dry straw of the wheat-fields no longer afforded them nourishment, they took up their line of march for the corn-fields, literally covering the ground in many places; sometimes gathering together into piles, and here casting their skins. This, being observed carelessly by farmers and others, leads them to declare that 'the chinch-bugs were destroying each other,' that 'they were dying,' &c.; the dry shells remaining behind being mistaken for the insect itself.

"I have seen the columns of these insects a full week on the march across the meadows and pasture-fields from the wheat to the corn field, and have even seen them swim a small stream of water that crossed their line of march. In former years the few border rows of corn, together with the 'fox-tail grass' (*Setaria*), carelessly left among the corn in cultivating, usually satisfied them. This latter grass is usually attacked in preference to the corn.

"In 1864, whole corn-fields were overrun by them; the stalks, especially below the ears, blackly covered through the day, were bleeding and literally ran from their numerous punctures. At length when they had attained the perfect state during the warm part of bright sunny days, they took to their wings, and literally filled the atmosphere, not much unlike an April snow-storm. This interesting phenomenon induced many to believe that they were leaving the country; but it was for an entirely different purpose—that of choosing their mates—for they never fly except in the love season. After a few days they might be found paired in corn-fields and other proper breeding grounds, producing a new generation. At this time in the month of August, 1864, my attention was very favorably directed to a small field of tender, thickly-sown corn for fodder, where they congregated in immense numbers, and continued until the frosts of autumn had killed the corn that they did not consume, and developed their progeny in unnumbered millions. During the day they resorted to the stalks of corn to feed upon the juice, but they passed the night usually upon the ground."—(Dr. Shimer.)

Dr. Le Baron, in his first article published in the Prairie Farmer in September, 1850, writes as follows:

"Meanwhile the grain, being deprived of its necessary nutriment becomes wholly blasted or much shrunken, whilst the straw turns white prematurely and at length crinkles down beneath the lancets of this infinity of phlebotomists.

"When the wheat becomes too much dried up to afford them nutriment, they leave the wheat-field and may be seen at this time running upon the ground in all directions in search of appropriate food. Next to wheat they usually attack oats, then corn, and lastly timothy or herds-grass; and if none of these are at hand, they will subsist upon some of the wild grasses. The Indian corn is so rapid and vigorous in its growth that it is not usually much injured; yet I have seen this season whole fields blackened with them, and large patches of corn blasted and prostrate, as if a fire had run over them.

"They migrate from one field to another by running over the surface of the earth. Nevertheless, when they are obliged to move to a distance the perfect or winged individuals readily take to flight, and they have been seen flying in dense swarms."

The following interesting account of their migrations, given by an Illinois farmer was published in the Proceedings of the New York Farmers' Club, June, 1866:

"In passing by a field of barley where the chinch-bugs had been at work for a week, I found them moving in solid column across the road to a corn-field on the opposite side, in such numbers that I felt almost afraid to ride my horse among them. Some teams were at work mending the road at this spot, and the bugs covered men, horses, and scrapers, till they were forced to quit work for the day. The bugs took 10 acres of that corn clean to the ground before its hardening stalks checked their progress. Another lot of them came from a wheat-field adjoining my farm into a piece of corn, stopping now and then for a bite, but not long. Then they crossed a meadow 30 rods into a 16-acre lot of sorghum and swept it like a fire, though the cane was then scarce in tassel. From wheat to sorghum was at least 60 rods. Their march was governed by no discoverable law, except that they were infernally hungry and went where there was most to eat. Helping a neighbor harvest in one of the few fortunate fields, early sown, we found them moving across his premises in such numbers that they bid fair to drive out the family. House, crib, stable, well-curb, trees, garden-fences—one creeping mass of stinking life. In the house as well as outside, like the lice of Egypt, they were everywhere; but in a single day they were gone."

Their migrations on foot seldom exceed 80 rods.

NATURAL AGENCIES WHICH ASSIST IN THEIR DESTRUCTION.

Many insects are subject to the attacks of enemies which appear to be adapted by nature to prey upon them. Unfortunately for our agriculturists this little pest seems to be followed by no such relentless enemies as those that pursue the army-worm, plant-lice, &c. Even the carnivorous species which wage such an incessant warfare against the rest of the insect tribes, appear to have little or no taste for such an unsavory morsel as the chinch-bug, and if we judge them by our own nasal organs we cannot blame them. Still there are a few that now and then prey upon them, but even these do not appear to follow up the work very vigorously; nor are they sufficiently numerous to make any material impression on the vast hordes of these insects that occasionally pervade our grain-fields.

The following statements copied from Mr. Riley's seventh report cover about all that is to be said in reference to them:

"As long ago as 1861, Mr. Walsh in his Essays upon the Injurious Insects of Illinois, published facts which tended to show that four distinct species of ladybirds preyed upon the chinch-bug. The first of these four is the spotted ladybird (*Hippodamia maculata* De Geer, Fig. 4), which also preys upon a great variety of other insects, attacking both the eggs of the Colorado potato-beetle and those of certain bark-lice.

Fig. 4.

Spotted Ladybird.

"In corroboration of the fact of its preying on the chinch-bug I may state that the Rev. Charles Peabody, of Sulphur Springs, informs me that he has repeatedly found it so feeding on his farm. The second species is the trim ladybird (*Coccinella munda* Say, Fig. 5) which is distinguishable at once from a great variety of its brethren by having no black spots upon its red wing-cases. The other two are much smaller insects, belonging to a genus (*Scymnus*) of ladybirds, most of the species of which are quite small and of obscure brown colors, and hard to be distinguished by the popular eye from other beetles, the structure of which is very different, and which, therefore, belong to very different groups and have very different habits.

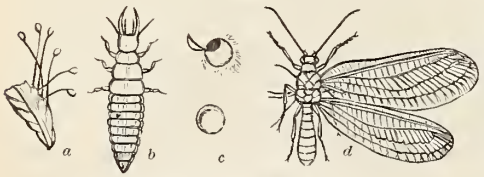
Fig. 5.

Trim Ladybird.

"In the autumn of 1864, Dr. Shimer ascertained that the spotted ladybird, which has been sketched above, preys extensively upon the chinch-bug. In a particular field of corn, which had been sown thick for fodder, and which was swarming with chinch-bugs, he found, as he says, that this ladybird 'could be counted by hundreds upon every square yard of ground after shaking the corn; but the chinch-bugs were so numerous that these hosts of enemies made very little perceptible impression among them.'

"In the same autumn, Dr. Shimer made the additional discovery that in the very same field of fodder-corn the chinch-bugs were preyed upon by a very common species of lacewing fly, which he described in January, 1865, as the Illinois lacewing (*Chrysopa Illinoiensis*). The description was republished, together with the substance of Dr. Shimer's observations, in the Prairie Farmer, of Chicago, Ill., accompanied with a non-characteristic wood-cut of the larva, cocoon, and imago. At this time Dr. Shimer favored me with two specimens of the perfect insect, and he likewise furnished Mr. Walsh with additional specimens. From these specimens it is evident that the species is the same as that described long before by Dr. Fitch as the weeping lacewing (*Chrysopa plorabunda*), Fig. 6. In 1868, I found the same species quite numerous in a wheat-field belonging to Mr. T. R. Allen, of Allenton, where its larvæ were perhaps feeding on the chinch-bugs, as they were found to do in North Illinois by Dr. Shimer. The lacewing flies all bear a striking resemblance to one another, both in size, shape, and color. Almost all of them, in the fly state, have a characteristic and disagreeable odor, resembling nothing so much as human ordure.

Fig. 6.



Lacewing fly, larva, eggs, and cocoon.

"According to Dr. Shimer, the weeping lacewing fly was not quite as abundant as the spotted ladybird among the fodder-corn, but still there were so many of them that he thought that 'there was one or more of

them for every stalk of that thickly-sown corn.' 'Every stroke of the cutter,' he adds, 'would raise three or four dozen of them, presenting quite an interesting spectacle as they staggered along in their awkward, unsteady flight.' And he not only actually observed the larvæ preying very voraciously on the chinch-bugs in the field, but he reared great numbers of them to the mature fly by feeding them upon chinch-bugs. His account of the operations of the larvæ when in captivity is so interesting that I quote it in full:

"'I placed one of the larvæ in a vial, after having captured it in the field in the very act of devouring chinch-bugs of all sizes, and subsequently introduced into the vial a number of chinch-bugs. They had hardly reached the bottom before it seized one of the largest ones, pierced it with its long jaws, held it almost motionless for about a minute while it was sucking the juices from the body of its victim, and then threw down the lifeless shell. In this way I saw it destroy, in quick succession, about a dozen bugs. Towards the last, as its appetite was becoming satiated, it spent five or more minutes in sucking the juices from the body of one bug. After this bountiful repast it remained motionless for an hour or more, as if asleep. Never for a single moment during the feast did it pause in the work. When not in possession of a bug it was on a search for or in the pursuit of others. It manifested much eagerness in the pursuit of its prey, yet not with a lion-like boldness; for on several occasions I observed a manifest timorousness, a halting in the attack, as if conscious of danger in its hunting expeditions, although here there was none. Sometimes when two or more bugs were approaching rapidly it would shrink back from the attack, and turning aside go in the pursuit of others. At length, awakening, it would renew the assault as before. On one occasion, when it was on the side of the vial, two inches up, with a large bug in its mouth, I jarred the vial so that it fell to the bottom and rolled over and over across the bottom, but, holding on to its prey, it regained its footing and mounted up to its former position. Occasionally the chinch-bugs would hasten to escape when pursued, as if in some degree conscious of danger.'

Fig. 7.

Insidious Flower-bug.

"The insidious flower-bug (*Anthocoris insidiosus* Say, Fig. 7), which is so often found preying on the leaf-inhabiting form of the grape *Phylloxera*, and which is not unfrequently mistaken for the chinch-bug, is quite commonly found in connection with this last, and in all probability preys upon it.

Fig. 8.

Many-banded robber.

"The many-banded robber (*Harpactor cinctus* Fabr., Fig. 8) also preys upon the chinch-bug. It is quite frequently met with, and I have detected it in the act.

"The common quail of the Middle and Western States (*Ortyx Virginiana*), otherwise known as the partridge in the Northern States, has long since been known as a most efficient destroyer of chinch-bugs and the fact was some time ago published by myself in the Prairie Farmer, and by others in various agricultural journals and reports. We also have the corroborative testimony of Dr. Shimer, who is a good ornithologist. In the winter time, when hard pushed for food, this bird must devour immense numbers of the little pests which winter in just such

situations as are frequented by the quail; and this bird should be protected from the gun of the sportsman in every state where the chinch-bug is known to run riot. It is gratifying to know that this fact has become sufficiently recognized to have gained for the bird legislative protection in Kansas. Prairie chickens are also reported as devouring it, but I do not know that any absolute proof has been given. Mr. J. W. Clarke, of Green Lake County, Wisconsin, also reports seeing the red-winged blackbird feeding on it.* Finally, Mr. B. W. Webster, of Austin, Cass County, and G. C. Brackett, Secretary of the Kansas State Horticultural Society, have both written me to the effect that ants destroy its eggs."

The most efficient of these aids appears to be the *Harpactor cinctus* or banded-bug. I received in 1878 notice from points in the Northwest that it was doing much service in destroying chinch-bugs, but it does not develop in sufficient numbers to make any serious impression on them in the years they are abundant.

To the list of enemies given in the foregoing extract we may add the frog, which, according to Professor Ross and others, consumes a large number. Professor Ross goes so far as to express the belief that the destruction of these animals by draining their natural haunts is one reason why the chinch-bug is enabled to multiply as it does in some seasons.

As before stated, they are perhaps more seriously affected by moisture than any other natural agency; and this fact has suggested to Dr. Fitch the idea of sprinkling, and to Mr. Riley irrigation, as remedies.

According to Dr. Shimer this species is occasionally subject to an epidemic disease that sweeps them away in immense numbers. The only-known instance of its appearance was in 1865, as shown in the following quotation from his article in the Proceedings of the Philadelphia Academy of Natural Sciences heretofore mentioned:

"*July* 16.—A farmer four miles from here informed me that a black coleopterus insect was destroying the chinch-bugs on his farm very rapidly; and although I found his supposition to be an error, yet I found many dying on the low creek bottom-land from the effects of some disease, while they are yet in the larvæ state—a remarkable and rare phenomenon for insects thus in such a wholesale manner to be dying without attaining their maturity, and no insect enemy or other efficient cause to be observed capable of producing this important result.

"*July* 22.—On the low grounds the young chinch-bugs are all dead from the disease above alluded to, and the same disease is spreading rapidly on the hills and high prairies.

"The weather has been very wet since the first of July, and the barley above alluded to, which I plowed beneath the ground, did not die, but assumed a yellow, sickly appearance; in its shady, compressed, unnatural position, the ends of the heads project from beneath the furrows. The chinch-bugs also remained alive for a time, but feeding on the sickly grain and shaded from the sunlight, what little we had, were attacked by disease in the same manner and about the same time as those on the low creek bottom-lands, meeting very rapidly the same fate, so that very few of them ever found their way to the neighboring corn.

"*July* 28.—Great numbers in all stages of their development are dying of the prevailing disease.

* Prairie Farmer, April 9, 1870.

"*August* 8.—The majority of the chinch-bugs yet alive are in the imago state, but they are being rapidly destroyed by the prevailing epidemic disease, more fatal to them than the plague or Asiatic cholera ever was to man, more fatal than any recorded disease among men or animals since time began. Scarcely one in a thousand of the vast hosts of young bugs observed at the middle of June yet remain alive, but plenty of dead ones may be seen everywhere lying on the ground, covered with the common mold of decomposing animal matter, and nothing else, even when examined by the microscope. Even of those that migrated to corn-fields a few weeks ago, in such numbers as to cover the lower half of the corn-stalks, very few are to be found remaining alive; but the ground around the base of the corn-hills is almost literally covered with their moldering, decomposing dead bodies. This is a matter so common as to be observed and often spoken of by farmers. They are dead everywhere, not lying on the ground alone, but sticking to the blades and stalks of corn in great numbers, in all stages of their development, larva, pupa, and imago.

"*August* 22.—It is almost impossible to find even a few cabinet specimens of chinch-bugs alive, so that I am quite sorry that I did not secure a large supply of specimens while they were so numerous, in former years; for it really appears quite probable that even cabinet specimens will be hard to secure, whereby to remember the fallen race of the unnumbered millions of former years.

"*September* 13.—It is generally believed among entomologists that insect enemies are the most efficient means in nature for exterminating noxious insects; but in this remarkable fact in the history of insects the great epidemic of 1865 (there can be no doubt about this being an epidemic disease, because the insects died without attaining their maturity) we find a greater enemy, the greatest insect enemy ever recorded, a dreadful plague, that in a few days almost utterly annihilated a race of beings living in the northern part of the valley of the Mississippi, outnumbering all the human beings that have ever lived on this planet since the morning of creation.

"This disease among the chinch-bugs was associated with the long-continued wet, cloudy, cool weather that prevailed during a greater portion of the period of their development, and doubtless was in a measure produced by deficient light, heat, and electricity, combined with excessive humidity of the atmosphere, whereby an imperfect physical (bug) organization was developed. The disease was at its maximum during the moist warm weather that followed the cold rains of June and the first part of July. The young chinch-bug spent a great portion of its time on or near the ground, where its body was colder than the atmosphere; hence, upon philosophical principles, there must have been an excessive precipitation of watery vapor in the bronchial tubes. These are the facts in the case, but in the midst of the great obscurity that envelopes epidemic diseases among men, it would be only idle speculation to attempt to define the cause more definitely than the physiological laws already observed seemed to indicate. At all events it will require many years of warm, dry summers, and accompanying winters of plenty of snow for protection, to reinstate the lost innumerable armies of this insect.

"During the summer of 1866 the chinch-bugs were very scarce in all the early spring, and up to near the harvest I was not able, with the most diligent search, to find one. At harvest I did succeed in finding a few in some localities.

"This epidemic disease was not confined to the chinch-bug alone. Dur-

ign the summer of 1865, I saw the larvæ of the common striped cucumber-bug (*Diabrotica vittata*) on the *stems* of melon and cucumber vines, above ground, a very unusual place for them. Always before this I have found them on the root, beneath the surface of the ground. This unusual position was evidently to escape the effect of some unnatural conditions. During the latter part of the summer of 1865, the imagos were very much less numerous than common.

"The apple-worm (the larva of *Carpocapsa* (*Tinea*) *pomonella* L.) was very numerous in 1863–'64, affecting almost every apple. In 1865–'66, they were very much less numerous. From observation I conclude that the disease was produced by the same cause that swept away the chinch-bugs.

"The potato-worm (*Sphinx quinque-maculatus*) was very numerous in 1864, doing much damage to tomatoes, &c. The pupæ were extremely abundant in the soil in the spring of 1865, but in autumn no observed larvæ had survived.

"The *Locustidæ* (grasshoppers) were also severely afflicted; the numerous dead, of all states, were easily seen everywhere, clasping the grass, weeds, &c., in the embrace of death. I might add much more of my observations on these insects, and greatly extend the list of afflicted species, but my object, to prove that epidemic diseases are *incomparably the most* important agents in all nature in destroying noxious insects, has been sufficiently illustrated. Neither is this a mere isolation, for I have observed diseases among various insects for the past twenty-five years."

Although the plague among the bugs in this instance appears to have been somewhat extraordinary, yet it is in accordance with facts ascertained in reference to other insects, and as Dr. Shimer is both a competent and reliable authority we accept his statement as correct, and believe with him that it was owing as the originating cause to the damp season. But we are inclined to believe that the moisture gave rise to a minute fungus as the direct cause of the death of the chinches.

I recollect very distinctly of a similar wholesale destruction of house-flies in Southwestern Virginia and East Tennessee in 1849, by an epidemic. So rapidly was the disease propagated and so great the destruction among the flies, which were unusually abundant, that the utmost caution in cooking and in drinking water was necessary. Every moist spot was covered with the dead and dying. This I am satisfied was caused by a fungus.

I observed a somewhat similar epidemic prevailing among the grasshoppers in Western Minnesota, Dakota, and Northern Iowa in 1872. All over the plains the dead were seen clasping the stems of grass and weeds, and before I was aware of this fact more than once I approached cautiously to capture a desired specimen, only to find it dead and rigid. In 1877 the rainy season evidently caused an immense destruction of the larvæ of *C. spretus*.

ARTIFICIAL REMEDIES.

As Dr. Le Baron in his second report as State entomologist of Illinois, which is now out of print, discusses somewhat thoroughly the subject of

remedies, I will quote in full his remarks before mentioning the remedies proposed by myself and others.

"*The plan of sowing grain so early in the spring as to get in advance of their depredations.*

"The well known fact that winter-wheat generally matures before the young brood of chinch-bugs makes its appearance, and thus escapes their ravages, naturally suggested the idea that the same end might be accomplished with respect to spring-wheat, if the seed could be got into the ground very early in the spring. However plausible this supposition may appear, the experiences of the past season would seem to show that any reliance based upon it must prove, in a great measure, fallacious. Notwithstanding that the last spring was dry and favorable for the early sowing of grain, and notwithstanding that it is universally understood by farmers that the earlier wheat can be sown the better for the crop, and therefore it may be presumed that wheat was sown unusually early, yet the result could scarcely have been more disastrous. I am not prepared to say that nothing can be gained by this course, but in view of the experiences of the past season, I do not see how we can place much reliance upon this method of escaping the ravages of the chinch-bug.

"In this connection we may advert to the plan of sowing certain stimulating substances, such as salt and lime, with the seed for the purpose of hastening the growth and the ripening of the grain. It has also been supposed that a pretty heavy dressing with such materials might render the soil obnoxious to the bugs. I have known of attempts being made to protect corn from the bugs, by the application of salt and air-slacked lime, but without any visible effect, and it is not probable that any quantity of such substances which we could reasonably apply to the soil would be effective in preserving our crops from these insects. But in the other point of view, that of hastening the ripening of the grain and thus placing it in advance of the depredations of the bugs, this plan seems to me to be well worthy of a trial. I was informed by a farmer living in Dixon that he tried sowing salt with his spring wheat, at the rate of one barrel to two and a half acres, and that upon the field so treated the crop was much larger than on the other portions, and ten or twelve days earlier. The effects of the salt will differ, of course, to some extent, like other applications, according to nature and condition of soil.

"*The attempt to save a part of our crops by preventing the migration of the bugs from one field to another.*

"It is well known that when the small grains become too mature and dry to afford nutriment to the chinch-bugs they migrate in vast numbers into the adjoining corn-fields, and generally destroy from a half dozen to a dozen or more of the outer rows, and nothing but the great extent of the fields of the West and the exuberance of the plants, which at this time have nearly completed their growth, preserve the corn-crop from the same destruction which has overtaken the smaller grains.

"As this migration takes place before the young brood have acquired wings, they necessarily travel on foot, and various attempts have been made to intercept their progress. The principal of these are a succession of furrows plowed across their path, and a barricade of fence-boards besmeared with coal-tar or kerosene-oil. The first plan, but very

partially successful, is so simple and easy of execution that it is always worthy of trial. I was informed by some farmers who practiced it the past season that it very materially checked their progress for the first day or two, so long as the furrow was fresh and the earth friable; but that a shower of rain or heavy dew for a succession of nights so consolidated the earth that the insects could pass over.

"The other plan is much more effective, but also much more troublesome and expensive. It consists of a barricade of fence-boards placed end to end and set edgewise into the ground, with the upper edge besmeared with some offensive substance, the one most commonly used being coal-tar. This method has been extensively resorted to the past season in the central part of the State, and especially in the neighborhood of the Bloomington gas-works, where the coal-tar is extensively manufactured. I was informed by one of the proprietors of the gas-works that nearly one hundred and fifty barrels of tar had been purchased at that establishment for this purpose. I had an opportunity of seeing this method put in practice, on a large scale, on the farm of Mr. Joshua Sells, of Bloomington. At the time of my visit Mr. Sells had discarded the boards as an unnecessary trouble and expense, and had adopted the simple and more expeditious plan of running a stream of tar from the spout of an old tea-kettle directly upon the ground along the exposed sides of his corn-fields. He found that a gallon of tar would extend about ten rods, so that a two-gallon kettle twice filled would furnish a strip of tarred ground the whole length of a forty-rod corn-field. The tar had to be renewed every other day, and oftener in case of rain. The insects would crowd up to the line in such numbers that in many places they would pile up from half an inch to an inch deep, and could be scraped up by the double handful. But so long as the tar was kept fresh not a bug would cross it. They were not prevented from crossing by the adhesive nature of the tar, but by its repulsiveness. The bugs would not touch it. They were destroyed by conducting them into perpendicular holes, or by shoveling them in and burying them. The usual price of coal-tar at the gas-works is about two dollars a barrel. This is the most effective means yet resorted to for intercepting the progress of these insects when in the act of moving from one field to another; but the trouble and expense of using it, especially at a distance from the places where the tar is manufactured, will probably prevent its ever being very generally practiced. The great deficiency of all such methods as a remedy for the chinch-bug is that, at best, they only protect that crop which is usually the least damaged by them.

"*The method of destroying the insects by burning corn-stalks and other rubbish in which they are supposed to hibernate.*

"We have just adverted to the fact that when the small grains fail the chinch-bugs migrate into the corn, and that at this time they travel on foot and confine themselves mostly to the outer rows. But shortly after this the young bugs acquire wings and then spread themselves over the fields in large flocks. It is a question of considerable importance, and one to which but little attention has been paid, whether these insects materially damage the corn-crop after this general scattering of themselves, in the latter part of summer. From the circumstances of the case, this question does not admit of a very easy solution. The fact that these insects require comparatively little nutriment after they have attained their winged and mature state, taken in connection with the

vast extent and luxuriance of the western corn-fields, and with the additional consideration that the crop, being at this time considerably advanced, the loss would be only comparative and therefore not easily discriminated—all this tends to involve the subject in much uncertainty.

"Mr. George W. Patten, of Delavan, Tazewell County, at whose house I visited in the height of the chinch-bug season, actively co-operated with me in the determination of this and other matters appertaining to these destructive insects. Mr. Patten took the pains to visit many of the farmers in his own and the neighboring counties, all of which were badly infested, for the purpose of making inquiries upon this point. He found it to be the general opinion that the bugs had damaged the crop very sensibly. As the whole State has suffered severely the past season for the want of rain, there was the additional difficulty in this case of distinguishing between the effects of the drought and that caused by the bugs. The insects themselves, however, furnish a key to the solution of this difficulty, by virtue of their gregarious habits. It appears that they do not scatter themselves indiscriminately over the field, but that they move in large flocks, not unlike their fellow-depredators, the blackbirds. Accordingly the corn-fields are found to be damaged in patches, and it is thought to a sufficient extent to materially diminish the crop.

"This general diffusion of the chinch-bugs over the corn-fields after midsummer, taken in connection with the common observation that they remain there until late in the fall, has naturally suggested the expediency of gathering the stalks together and burning them, after the corn has been harvested, with the view of destroying the bugs. It has also been advised, in order to make the remedy more sure, to burn the dead grass and other rubbish which accumulates around the borders of fields and fences. My own observations have led me to the conclusion that this remedy also, in the way that it would be likely to be generally put in practice, can be of but little avail. Upon examining an infested corn-field late in October, I found that the bugs had left the upper part of the stalks and had collected about the one or two lowermost joints, under the sheaths of which they were congregated. They had gone thither partly perhaps to avoid exposure to the cold winds of approaching winter, but chiefly, no doubt, for the sake of the nutriment which they could still extract from the lower joints of the stalks after the upper ones had become dead and dry. Upon visiting the same field a month later (November 22), after winter had virtually set in, the mercury standing 15° above zero, the ground whitened with snow, after cattle had had the range of the field, very few bugs could be found. A few were found in deep cracks in the stalks, and a few were lying torpid upon the ground close to the roots of the corn. Upon digging up a number of hills no bugs could be found beneath the surface. Where the great majority of them had gone was not apparent. It is known that some of these insects hibernate under boards and flat stones lying loosely upon the ground, and similar situations. Dr. Shimer found many of them under the fallen leaves of apple trees, but nearly half of these were dead. I have heard of their being seen flying in flocks towards the woods late in the fall. I cannot vouch for the truth of this, but I found them this fall in small numbers under the loose bark of prostrate logs, in the edge of the woods, half a mile from any tillage land. I also found them congregated on the under side of some flat stones lying upon stubble land. Within a few rods from them was a ravine filled with long dead grass, but I could find no bugs among the grass. It is proper to say, however, that this last was not a badly infested locality.

"With the view of obtaining further observations upon this part of the subject, still later in the season, and especially in the badly infested district, I wrote to my friend Mr. Patten, whose assistance I have above been happy to acknowledge, and requested him to examine some of the corn-fields in his vicinity. From Mr. Patten's reply, under date of December 20, I extract the following valuable observations:

"'Since the receipt of your letter, I have at different times examined corn-stalks with a view to finding chinch-bugs, but have not succeeded in finding a live one. I have a piece of ground sown to fall wheat, from which I had carried what few stalks of corn the bugs had left standing, and had thrown them in heaps along the edges of the field. These heaps I have been examining, and have always found large numbers of dead bugs, but no live ones. To-day it occurred to me that perhaps by bringing them into a room of proper temperature they might show signs of life; but after giving them a fair test I have been unable to bring any to life. In all shocked corn that was put in shock before the frost killed the corn, I find large numbers of dead bugs, from the ear down. In later-cut corn they do not seem to be so numerous. In the stalk-fields I find very few bugs, either dead or alive. To-day I chopped up stalks by the roots, examining each sheath from the ground up; then opened the stalks, both sound and fractured ones, but found nothing that could be recognized as ever having been a chinch-bug. That the bugs disappeared from their usual haunts upon the approach of severe cold weather, I am fully satisfied, but where they now are I have failed to ascertain. The first thought is that they have gone below the surface of the ground; but when we consider that our cold weather came so suddenly upon us that the first night the ground was frozen to the depth of three or four inches, it hardly seems possible that the chinch-bugs could have penetrated it.'

"Mr. Patten made the following curious observation bearing upon the hibernation of these insects:

"'About the time of our first frosts, while gathering hazel-nuts in the timber, I observed that in nearly every instance where a nut had been bored into by an insect or grub, from one to four chinch-bugs had found their way into the nut. Whether they were there for winter quarters, or were feeding upon the partly-consumed nut, was a question which I could not solve.'

"Mr. Patten concludes his letter with the following practical remarks:

"'As to burning the stalks with a view to destroying the chinch-bugs, I have but little faith in it. Could the stalks be burned before excessive cold weather sets in, very probably a large portion of the bugs could be destroyed, but by the time the corn can be harvested and the stalks are dry enough to burn, the chinch-bugs have taken to their legs or wings and left for parts unknown.'

"What strikes us as remarkable in these statements of Mr. Patten is that all the chinch-bugs which he discovered appear to have been dead. The question arises, did they die a natural or unnatural death? Had they arrived at the natural term of their lives, or were they killed by the sudden accession of cold weather, or by some other and unknown cause? As many of these insects were found in tolerably well-protected situations, that is, under the sheaths of corn-stalks which had been laid in piles, it does not seem probable that they could have been killed by the first cold snap of winter. The most plausible explanation of the case I can give is that these dead insects were the old bugs of former broods which had arrived at the end of their natural lives, whilst the instincts of the new brood, which are to perpetuate the race in the suc-

ceeding year, had led them to seek out more secure and permanent retreats.

"From all this we conclude that late in the fall, and when winter is about to set in, chinch-bugs, like most other insects, seek secure and hidden retreats where they will not be exposed to the snows of winter nor the cold rains of the fall and spring, and therefore that the burning of corn-stalks or other loose rubbish, late in the fall, will destroy but a very small proportion of them. The only way to accomplish this end to any considerable extent would be to husk the corn as early as possible, and then cut off the stalks close to the ground and burn them. But even here it is very questionable whether the bugs would not leave the stalks before they were dry enough to burn. But in any event, the plan is scarcely available in actual practice. In the first place, most farmers depend upon their stalks for fall feed for their cattle; and if a farmer should conclude to sacrifice his stalks for this purpose it would insure him no immunity from the inroads of the insects in the spring from surrounding localities.

"It may seem to be poor encouragement to show that the plans and preventives upon which we have been taught chiefly to rely, for checking the ravages of this formidable insect, are of little real efficacy. But it is best to know the truth and to see the evil in its true proportions. The first step to take in meeting a real danger is to divest ourselves of all false securities.

"*The prevention of their breeding to any serious extent by abstaining from the cultivation of those grains upon which they chiefly subsist.*

"If, then, our supposed remedies for the chinch-bug prove in a great measure fallacious; if experience shows that we cannot get our grain into the ground so early but that the bugs will be even with us; if plowed furrows and tarred barricades can only be resorted to when most of the mischief has been done; and if these insects hide themselves so securely in winter that burning cornstalks and other rubbish can destroy, at best, but a very small proportion of them; and, finally, if their natural enemies are so few as to make no perceptible impression upon their countless hosts, then we are driven to inquire, with the more earnestness, whether we can take a step in advance of all these imperfect palliatives, and absolutely prevent the breeding of these noxious insects, to any serious extent, by abstaining from the cultivation of those crops which are most congenial to their nature. It may seem a hard alternative to give up the raising of some of our most valuable crops at the behest of these nauseous *Hemiptera*, but a hard remedy is better than no remedy. It is better to save your labor and your seed than to lose seed and labor and harvest likewise.

"What, then, does experience teach us with regard to the breeding-habits of these insects and the plants upon which they mostly subsist?

"When the warmth of spring has become sufficiently confirmed to penetrate the hidden recesses where insects hibernate, many different species which have wintered over in the winged state are seen emerging from their retreats and launching out upon the vernal air, apparently rejoicing in their new lease of active existence. Among these, in the localities where they prevail, the chinch-bugs are to be seen, flying in dense flocks, in search of the plants at the roots of which it is their instinct to deposit their eggs. Mr. Sells, of Bloomington, informed me that whilst plowing about the first of May his clothing and his horses were thickly sprinkled over with them, and that the horses were

seriously annoyed in breathing by the bugs flying into their nostrils These insects deposit their eggs at the roots of our cultivated cereals and some of the grasses which most nearly resemble them. As the chinch-bug is a native insect it must have subsisted originally upon the native grasses, before the cultivated cereals were introduced. The chinch-bug was then a rare insect, only occasionally met with by collectors. Mr. Thomas Say, who spent twenty years in collecting and describing insects in many parts of the United States and their Territories, first described the chinch-bug from a single specimen, and the only one he had ever seen, and which was captured in the eastern part of Virginia. But there is no difficulty in obtaining specimens now. We have ourselves been the means of their excessive multiplication, by furnishing them with a superabundance of congenial food in the shape of our cultivated grains.

"But the question now before us is, upon which of these grains do they thrive best, and will they thrive sufficiently upon all of them to multiply to a serious extent, or are they restricted in their food-plants to such a degree that we have it in our power to get rid of them at any time by abandoning the cultivation of some one or more of these grains.

"It seems remarkable that these insects should make a selection between plants so similar, both in nature and appearance, as are several species of what are known as the small grains. Yet abundant experience has taught us that they do make a very decided selection. It is known that they always give a strong preference to spring wheat and barley, where these are at hand. Where these two grains are not available, they will oviposit upon either of the others, and perhaps to about an equal extent. We know this from the fact that all of these grains are sometimes considerably injured where chinch-bugs abound, and the chief reason, probably, why winter wheat does not suffer as much as spring wheat is that this crop gets nearly matured before the new brood of bugs makes its appearance, and accordingly we sometimes see late pieces of winter wheat almost as much damaged by them as the spring wheat. But the main question is whether, if no spring wheat or barley be raised, the chinch-bugs will continue to thrive and multiply to excess upon any other kinds of grain. The general opinion is that they will not. And yet a sufficient number of exceptional cases occur to throw some doubt upon the matter, and to induce some farmers to hold the opposite opinion. Chinch-bugs are, in some years, found in considerable numbers in the southern part of this State, where the winter grains exclusively are raised. A number of cases, also, like the following, have come to my knowledge:

"Mr. D. Veatch, of Livingston County, stated to me that winter wheat, oats, and corn were all seriously damaged in his neighborhood, though but little spring wheat was raised; and on his own farm a field of thirty-six acres of oats was not worth harvesting, though no spring wheat had been raised in its vicinty for the last five years. And a somewhat similar case was related to me by a Mr. Vail, of Tazewell County. More definite testimony is needed upon this subject. My opinion, from my present knowledge, is that such cases are rare and exceptional, and perhaps could be easily explained if we knew all the circumstances.

"From the foregoing observations we draw the following practical conclusions:

"1st. That it is useless to attempt to raise spring wheat or barley where chinch-bugs have been present in any considerable numbers the preceding year, unless we have reason to believe that they have been killed off by heavy rains.

"2d. That in case the season should be favorable to the propagation of the chinch-bug, we always have it in our power to get rid of these pests by the abandonment of these two kinds of grains for one or two years. But to make this course effective there must be a concert of action by farmers over a considerable section of country.

"3d. That the presence of chinch-bugs the preceding year will not prevent the raising of corn or any of the winter grains.

"4th. With regard to oats, the testimony thus far is that if this grain be sown where chinch-bugs abound, and especially if it be sown exclusively, it will be damaged to a greater or less extent the first year, but that the bugs probably will not continue to breed in it to any great extent in succeeding years.

"*Other proposed remedies.*

"It may be proper before closing to advert briefly to a few of the more plausible of the other remedies for the chinch-bug which have been suggested. It has been proposed to burn over the infested and ruined grain fields just before the time for the bugs to leave them, with the view of destroying the bugs and thus preventing their migration into the corn. This is a good suggestion, provided the grain is dry enough to burn before the bugs leave it; and, also, provided it will burn low enough to kill the bugs, which in this case would all drop to the ground. The plan would be most likely to succeed by the aid of dry straw and favorable condition of wind and drought.

"Another plan which has been proposed is to sow a small proportion of winter rye (one bushel to twelve) with the spring wheat, with the expectation that the bugs would feed upon the green rye near the ground, whilst the more rapidly growing wheat would rise above it and come to maturity. This suggestion is founded upon the mistaken notion that the chinch-bugs feed upon the green blades of the grain, whereas they imbibe their nutriment, first from the roots, and afterwards from the lower joints of the stalk.

"The well-attested fact that chinch-bugs are checked in their operations by rain induced Dr. Fitch to advise the sprinkling of wheat-fields —or at least those parts of them where the bugs first made their appearance—with water, by means of a garden engine, or some other contrivance. This would be an interesting experiment where the field is very small and the supply of water abundant; but we presume the doctor would hardly recommend this plan as practicable on the forty thousand square miles of territory overrun this year by chinch-bugs at the West.

"All the attempts to check the depredations of the chinch-bugs by throwing offensive substances upon them, such as tarred saw-dust, salt, or lime, have proved to be labor lost. The recommendation of salt application had the run of the newspapers the past season. Both this and the air-slaked lime were thoroughly tried by Mr. Sells, of Bloomington, without making any perceptible impression upon the bugs."

Mr. O. B. Nichols, of Clinton County, Illinois, writing to the Prairie Farmer of December 2, 1858, gives the following as his plan for preventing their increase:

"My plan to keep clear of them is this: In the fall I plow under all the weeds and grass that I can get to with the plow. I have my fields so arranged that I can turn in my sheep and cattle to eat the weeds and grass out of the fence corners before I sow my wheat, and in the bal-

anee of my fields I turn on during winter, and if I have any fenee eorners that I eannot feed out, I take a toreh, and the boys follow with buckets of water and tin cups, and I burn up the grass and weeds. I feed all my corn fodder and straw to my cattle and other stock, whether they need it or not. I leave nothing on the plaee after the 1st of May for them (the bugs) to harbor in."

Although long ago recommended, and considered of doubtful utility by so good an entomologist as Dr. LeBaron, it is in substanee, as will be seen hereafter, what the present writer considers one of the most reliable praetical remedies yet suggested.

Dr. Fitch, speaking of measnres for destroying this pest or preventing its injuries, remarks as follows:

"Nor has any mode for destroying this insect or preventing its depredations been discovered of such efficaey as to bring it into pnblie notice and favor. When they are migrating from one field to another, it has been reported that they have been arrested by digging a trench before them, up the ernmbling dirt of the sides of whieh they are mnable to elimb; and when the whole colony is thus imprisoned, they have been eovered with straw and burned. By burning the dry leaves of the forest in plaees where they have settled in numbers, multitudes have been destroyed. A subseriber to the Southern Planter (vol. xv, p. 275) says he knows that strong soapsuds will kill them, when on eorn, if a half gill or gill be ponred on eaeh stalk; a labor not half so great as a single hoeing of the crop is. When this inseet beeame so nmnerous in North Carolina, in 1839, Mr. J. W. Jeffreys proposed that the farmers and planters should all abandon the sowing of wheat for two or three years, he deeming this the only measure by which it was possible to snbdne it. Dr. Le Baron thinks it improbable that any remedy ean ever be diseovered whereby to prevent its devastations. My own belief is very different. I do not think Providence has sent any injurious insect into our world but that when we come to study its history and habits, and become fully acquainted with its economy, we can discover some point where it is assailable, and hnman ingennity will be able to devise methods by whieh it will be practieable either to destroy the insect or to shield the vegetation on which it preys from its depredations, though often, no donbt, much patient investigation and many experiments, conducted by different persons, will be neeessary before we can arrive at the most eertain and sueeessful remedies.

"As regards the chineh-bug, if the facts reported are true, we think they point us to a feasible mode for snbduing it. They indicate that moisture is most uncongenial to this insect. If, when it is overrunning the land in myriads, a wet season arrives, it is at onee quelled in its career. Mr. Williams speaks of its ravages as having been perceptibly ehecked by a single heavy rain. And it appears from the statement of Mr. Albert Burnet that so slight a eireumstanee as the dew evaporating before the morning snn, first npon the south and east sides of a field, often eanses it to congregate upon those sides of the field exclusively. In view of these faets it would seem that by drenching that part of a field in whieh these inseets are elustered with water, by means of a fire or a garden engine, they may be washed from the plants and destroyed. Though it will be a formidable task to shower a large wheat-field profusely, yet if the erop can hereby be saved from ruin, it will amply repay the expense. But commonly it is only a narrow strip upon one side of the field whieh will require this operation. And where there is a

brook or stream of water passing through or adjacent to a wheat field, this measure can certainly be resorted to, repeatedly should it be necessary, at no great cost. When the small red bugs, the tender young larvæ of these insects, have made their appearance and are clustered about the roots of wheat plants in the month of June, they can probably be more easily destroyed than at any subsequent stage of their lives. And it is earnestly to be hoped that some one who is conveniently situated for testing the efficacy of this measure will do so and make the result known to the public."

Mr. Riley, although mentioning and discussing, in the article on the chinch-bug, in his seventh report, the various remedies against this pest, lays particular stress on irrigation as a means of destroying it, remarking as follows:

"When a field of wheat or barley or rye is once overrun with Chinch-bugs, man is, in the majority of cases, powerless before the unsavory host, and his only hope is in timely rains. The great majority of noxious insects may be controlled even at the last hour, but a few—and among them is the Chinch-bug—defy our efforts when once they are in full force upon us. There are several applications that will kill the insect when brought in contact with it, and I have known a few rows of corn to be saved by the copious use of simple hot water; but the application of all such direct remedies becomes impracticable on the scale in which they are needed in the grain-fields of the West. Irrigation, where it can be applied—and it can be in much of the territory in the vicinity of the Rocky Mountains, where the insect commits sad havoc; and with a little effort, in many regions in the heart of the Mississippi valley—is the only really available, practicable remedy, after the bugs have commenced multiplying in the spring. *I wish to lay particular stress on this matter of irrigation*, believing, as I do, that it is an effectual antidote against this pest, and that by overflowing a grain-field for a couple of days, or by saturating the ground for as many more in the month of May, we may effectually prevent its subsequent injuries. In the article on the Rocky Mountain locust, I may have something more to say on this matter of irrigation. We cannot at the critical moment expect much aid from its natural enemies, for these are few, and attack it mostly in the winter-time. We must, therefore, in our warfare with this pest, depend mainly on preventive measures where irrigation is impossible."

Having made observations in reference to the habits of this insect, and finding that it wintered in the perfect state, I suggested, in 1859, burning over the infested fields in the winter as perhaps the best means of destroying them, and am still inclined to look upon it as the best practical means of counteracting them that is susceptible of general adoption. Irrigation is undoubtedly the most effective method of destroying them wherever it can be practiced, and should in such favored situations supersede every other remedy. Unfortunately, in a very large part of our territory where this insect proves most destructive, this remedy is not feasible, and hence some other must necessarily be adopted. But, as indicated in Mr. Riley's report, it is the only effectual means that can be resorted to in the spring after the bugs have commenced multiplying, unless the crop is sacrificed; hence the only plan the farmer can resort

to, to counteract them, where irrigation is impossible, consists in preventive measnres. It is possible, as will hereafter be shown, to prevent n a large measnre injury to corn by the second brood, owing to the peculiar habit of the species of migrating on foot.

Before discnssing further the remedies to be adopted, let us consult the statistical reports and see which of the two great products, wheat and corn, snffer most from the depredations of this pest, in order that we may know for which these remedies are most needed. For this purpose we will limit our investigations to the Northwestern States, Indiana, Illinois, Missouri, Iowa, Wisconsin, Kansas, and Nebraska, and to the three great chinch-bug years 1864, 1871, and 1874, as the statistics for these States and years are the most complete and will suffice for the object in view.

By taking the yield for the years 1870, 1871, and 1872, we shall be able to detect any material variation in the crop of 1871.

We use the crop statistics of the Agricultural Department.

Total yield of wheat.

	1870.	1871.	1872.
	Bushels.	*Bushels.*	*Bushels.*
Indiana	20, 200, 000	19, 190, 000	19, 381, 000
Illinois	27, 115, 000	25, 216, 000	24, 711, 000
Missouri	6, 750, 000	12, 825, 000	7, 695, 000
Iowa	20, 445, 000	18, 400, 000	22, 080, 000
Wisconsin	20, 485, 000	18, 436, 000	22, 307, 000
Kansas	2, 343, 000	2, 634, 000	2, 155, 000
Nebraska	1, 848, 000	1, 829, 000	2, 500, 000
Total	99, 186, 000	98, 530, 000	100, 829, 000

Yield of wheat per acre.

	1870.	1871.	1872.
	Bushels.	*Bushels.*	*Bushels.*
Indiana	11. 0	12. 0	12. 4
Illinois	12. 0	12. 3	12. 1
Missouri	13. 0	13. 4	8. 8
Iowa	12. 5	10. 8	12. 6
Wisconsin	13. 4	12. 2	14. 3
Kansas	15. 0	15. 9	11. 6
Nebraska	14. 4	10. 3	12. 2
Average by States	13. 04	12. 41	12. 0

Adopting a similar plan in reference to 1874, we find the yield of wheat in the same States, for 1873, 1874, and 1875, as follows:

Total yield of wheat.

	1873.	1874.	1875.
	Bushels.	*Bushels.*	*Bushels.*
Indiana	20, 832, 000	23, 331, 000	17, 280, 000
Illinois	28, 417, 000	30, 122, 000	27, 300, 000
Missouri	11, 927, 000	15, 385, 000	11, 160, 000
Iowa	34, 600, 000	33, 908, 000	29, 800, 000
Wisconsin	26, 322, 000	18, 436, 000	25, 200, 000
Kansas	4, 330, 000	9, 455, 000	(?)12, 700, 000
Nebraska	3, 584, 000	3, 619, 000	3, 400, 000
Total	130, 012, 000	134, 256, 000	126, 840, 000

Yield of wheat per acre.

	1873.	1874.	1875.
	Bushels.	*Bushels.*	*Bushels.*
Indiana	11.2	12.2	9.0
Illinois	13.5	11.5	10.5
Missouri	12.8	13.5	9.0
Iowa	13.0	11.6	9.7
Wisconsin	16.5	11.5	14.0
Kansas	14.0	13.7	(*l*) 17.0
Nebraska	15.5	11.6	9.8
Average by States	13.79	12.23	11.29

It is apparent from a glance at these tables that there was no marked variation in the wheat-crops of the Northwest in 1871 and 1874, which can be attributed to the depredations of the chinch-bug. But before discussing them we present the following similar tables in reference to the corn-crop:

Total yield of corn.

	1870.	1871.	1872.
	Bushels.	*Bushels.*	*Bushels.*
Indiana	113,150,000	79,205,000	85,541,000
Illinois	201,378,000	203,391,000	217,628,000
Missouri	94,990,000	87,390,000	105,741,000
Iowa	93,415,000	99,019,000	101,989,000
Wisconsin	19,995,000	21,394,000	21,180,000
Kansas	16,685,000	24,693,000	29,631,000
Nebraska	5,163,000	7,228,000	7,589,000
Total	544,776,000	522,320,000	569,299,000

Yield of corn per acre.

	1870.	1871.	1872.
	Bush.	*Bush.*	*Bush.*
Indiana	39.5	35.7	38.7
Illinois	35.2	38.3	39.8
Missouri	31.4	38.0	37.0
Iowa	32.0	42.5	39.8
Wisconsin	38.0	37.7	38.0
Kansas	28.0	40.0	38.5
Nebraska	30.0	41.5	37.8
Average by States	33.44	39.10	38.51

Total yield of corn.

	1873.	1874.	1875.
	Bushels.	*Bushels.*	*Bushels.*
Indiana	67,840,000	74,624,000	95,000,000
Illinois	143,634,000	133,579,000	280,000,000
Missouri	70,846,000	46,049,000	128,000,000
Iowa	105,200,000	115,720,000	160,000,000
Wisconsin	16,308,000	15,492,000	15,200,000
Kansas	47,000,000	16,065,000	76,700,000
Nebraska	7,000,000	3,500,000	28,000,000
Total	457,828,000	405,029,000	782,900,000

Yield of corn per acre.

	1873.	1874.	1875.
	Bush.	*Bush.*	*Bush.*
Indiana	25.6	27.0	34.0
Illinois	21.0	18.0	34.3
Missouri	23.5	16.0	36.6
Iowa	29.0	29.2	35.0
Wisconsin	30.0	28.2	21.0
Kansas	39.1	10.5	40.0
Nebraska	35.0	10.0	40.0
Average by States	29.03	19.84	34.41

Although fully aware that the crop statistics as given in the annual reports of the Agricultural Department are far from being as accurate as desirable, yet they are as good as can be obtained by the means at the disposal of that department, and are moreover our only source of information on the subject. From some investigations I have made in my own State, I am inclined to think that as a rule they are in excess of the true figures, but on the whole approximate sufficiently near the true amounts for all ordinary or general purposes. I prefer, therefore, to rely upon them as a basis of calculation, rather than the unofficial statements given by others.

Taking these as our guide, we see at a glance, as before remarked, that so far as the yield of wheat was concerned, in 1871 and 1874, the depredations of the chinch-bug in the States named, although these are the ones in which it was most abundant, had no marked effect. Although the aggregate amount produced in 1871 was a little less than that of 1870 or 1872, yet the yield per acre was actually a little more than in 1872, and but three-fifths of a bushel less than that of 1870. It is, therefore, more than probable that the calculations of Dr. Le Baron and others in reference to the loss on wheat in 1871 is largely in excess of the correct amount, and was probably made up chiefly from the guesses of correspondents, and assuming the destruction was equal in all parts of the area embraced. The same thing may be said in reference to the calculations of Dr. Shimer and others in reference to the loss in 1864, for in Illinois, to which State these chiefly referred, the yield of wheat in 1864 was, according to the statistical report, actually 3.5 bushels more per acre than in 1865, and the total amount nearly 8,000,000 bushels more; but in reference to corn the case was reversed. In these earlier calculations another cause of error arose from the fact that no reference was made to these statistical reports as checks and guides. I have no doubt but that the loss occasioned by this insect in 1874 was far greater than in any previous year, yet Mr. Riley in reference to Missouri, and the writer in reference to Illinois, applying these checks so as to eliminate error as far as possible, although finding the loss truly alarming, produced no such figures as the calculations relating to 1864 and 1871. We also found that the loss on wheat was confined chiefly to the spring variety, and was really much less than had been supposed, though of

sufficient importance to demand the attention of agriculturists and the government, running up in some years to millions of dollars. For, notwithstanding the showing of the statistical report, that this insect did, in 1864, 1871, and 1874, destroy large amounts of wheat, especially in the spring-wheat belt, is too well known to be controverted by any statistics.

There are strong reasons for believing that the habits of the species have somewhat changed since it first came into notice as injurious; so that instead of being more destructive to the wheat-crop, as formerly, it is now more injurious to corn. A farmer writing to the Prairie Farmer, October 18, 1873, makes the following statement on this point:

"I have, as a farmer, suffered from the ravages of the chinch-bug for twenty-eight years; it has steadily increased in numbers. While *at first it only injured oats and spring-wheat*, it now swarms in our cornfields and injures our fall-wheat. * * * I have seen corn not more than six inches high destroyed by them. Years ago it was generally thought, where I then resided, that we should have to stop raising spring-wheat to get clear of them, *as it was then the only crop seriously injured;* now we would have to make our land a desert to starve them out."

If we turn now to the corn statistics we shall find that so far as the Northwest is concerned this is the crop that suffers most from this pest, and that in some years the loss, estimated by the most careful rules, is absolutely enormous.

Even in 1864 the effect of this insect on this crop is manifest in the statistics; to show this we present a table showing the production of the States named, for the years 1864 and 1865.

Total yield of corn.

States.	1864.	1865.
	Bushels.	*Bushels.*
Indiana	74, 284, 363	116, 069, 316
Illinois	138, 356, 135	177, 095, 852
Missouri	36, 635, 011	52, 021, 715
Iowa	55, 261, 240	62, 997, 813
Wisconsin	10, 087, 053	13, 449, 405
Kansas	4, 673, 081	6, 729, 236
Nebraska	1, 366, 622	2, 494, 084
Total	320, 663, 505	430, 857, 421

Yield of corn per acre.

States.	1864.	1865.
	Bushels.	*Bushels.*
Indiana	29	40. 6
Illinois	33	35. 2
Missouri	26. 8	39
Iowa	36. 7	42. 7
Wisconsin	31	41. 5
Kansas	25	41. 2
Nebraska	28. 5	46. 5
Average by States	30	40. 95

Here we see a difference of 10 bushels per acre in favor of 1865, showing a loss in 1864, after allowing for the difference in acreage, of about 100,000,000 bushels, which was largely owing to the chinch-bug.

The statistics of 1871, it is true, fail to show any marked loss; in fact, the yield per acre, as shown, was larger this year than in 1870 or 1872, but there was evidently some change in the method of computing the acreage, probably caused by the census returns for 1870, and hence it is impossible to make a true comparison in this respect. But even making allowances for this, the loss in the corn-crop does not appear to have been severe except in Indiana, which could not have been very largely owing to the depredations of the chinch-bug.

On the contrary, the statistics for 1873, 1874, and 1875, as above given, bring out very clearly the loss in 1874 to this crop. The yield per acre in 1874 was nearly 10 bushels less than in 1873 and nearly 15 bushels less than in 1875. If we take the acreage in 1874 and estimate the yield at but 30 bushels per acre, which is but seven-tenths of a bushel more than in 1873 and nearly 4½ less than in 1875, we shall find the aggregate loss to have been a little over 200,000,000 bushels. By comparison with the loss on this crop in other States in 1874, we find that about 40 per cent. of it is to be attributed to the drought of that season, the remaining 60 per cent. almost entirely to insects, the chinch-bug and grasshoppers, or locusts. Here, then, is a loss on corn alone in these seven States in one season by insects of some forty or fifty millions of dollars. Indiana, Illinois, Wisconsin, Eastern Missouri, and Eastern Iowa sustained more than two-thirds of the entire loss, and this was occasioned by the chinch-bug.

It is evident, therefore, from these facts, that while the loss to the wheat-crop occasioned by this insect is large, it is greatly exceeded by that to the corn-crop.

Let us now return to the consideration of the means to be adopted for their destruction and preventing their depredations.

Burning.—As the bugs from which the future generations are to be developed hibernate in the perfect state, as has heretofore been shown, it is evident that if these can be destroyed their development will be prevented, and for each female destroyed, which sex is largely in excess of the males at this season, numbers of the spring brood will virtually be exterminated. It should also be remembered that at this time their number is reduced to a minimum and that they are quiescent. If it is possible, therefore, to reach their retreat with fire, this will be the most effectual method of destroying them where irrigation is impracticable.

But Dr. Le Baron, as we have seen, believes this will be ineffectual, because the bugs, as he finds, do not remain on the cornstalks during the winter, but seek other quarters in which to hibernate. That they do so where the corn is not cut and shocked is undoubtedly true to a very large extent. I have also observed the same fact, mentioned by Mr. Patten, that to a large extent those found after winter sets in under

sheaths of the lower joints of the stalks are generally dead. These, I think, are chiefly the males; possibly they are, as he suggests, in part, at least, the old ones of the preceding brood. Although, when hard pressed, they sometimes hide beneath the clods, yet this is the exception and not the rule; they seek shelter wherever it can be found in and around the field. So far, therefore, as it is possible to do so, fire should be carried to these surrounding hiding-places. In timbered sections the leaves should be burned, and, as was Mr. Nichols's custom, the fence corners should be cleaned and burned. Although a large number, on account of the impossibility of reaching them, will escape, yet, if this method is thoroughly carried out, the greater portion will be destroyed.

But in order that this remedy may be effectual all the farmers in the infested district must act in concert, otherwise the labor of one will be rendered valueless by the neglect of another.

In order that this concert of action may be brought about, it might be well for the States infested by this pest to enact laws giving the officers of towns or counties authority when danger was apprehended to compel action. But this need not be done annually, as our knowledge of the habits of the insect is sufficient, if properly used, to give us warning of the danger. Two successive favorable—that is, dry—years are required to develop them in sufficient numbers to cause any serious injury. In the winter following a rainy season they will be reduced to a minimum in respect to numbers, and although the following season may be dry, they cannot increase to the same extent possible when two favorable seasons come in succession. The second brood may excite some alarm, but it will not be sufficiently numerous to inflict any serious injury. It is also evident that four successive broods, without any counteracting influence to check them, will produce more than two broods.

If the season has been dry, and an examination in the fall shows them to be present in considerable numbers, although they have done no material injury nor even attracted general attention, yet it may be set down as probable, in fact almost certain, that if the next is dry, unless killed by an unusual winter, they may be expected in destructive numbers. It is true that they sometimes appear in great numbers when no complaint has been made the previous season; but if a careful examination had been made the numbers hidden from the cursory glance would have caused apprehension of danger.

If the season is wet examination is unnecessary, but if it is dry search for them should be made by every farmer in the fall before cold weather sets in, and in and around every field where found, as soon as it is possible to do so, every hiding place should be subjected to a fiery ordeal. Dr. Le Baron suggests that the farmers need the stalks for fodder, but it is better to sacrifice them one season than to abstain from sowing small grain.

When they are in sufficient numbers to do serious injury or excite apprehension of danger from them the next season, it might be well to adopt

the southern plan of topping the corn. This will cause the grain to harden more rapidly and the stalk to dry the sooner, so that the corn can be gathered at an earlier day, when the stalks can be cut and raked into windrows and burned before the bugs have left them.

Mr. Riley recommends that "shocks should be made at intervals to attract the bugs. The bugs will then congregate in these shocks, which may be burned at any time during the winter"—after the ears have been removed. As confirming this opinion he quotes the following from a letter of one of his correspondents: "The most compact and destructive army of chinch-bugs I ever saw started from sorghum bagasse which had been used as manure. Might the insects be trapped to any extent worth mentioning by exposing heaps of rubbish in conspicuous places in August, and burning the same in November?"

If it is found at the time wheat is harvested that the bugs have not taken their departure, as is the case in the winter-wheat section, this fact may be taken advantage of to destroy a very large portion of them. If the wheat is at once threshed and the straw scattered over the stubble and burned it will destroy all or most of those that are there. I know of one section in Southern Illinois where this has been practiced for a number of years by the German farmers with good results.

Further information is desired in reference to the time the migrations take place in the different sections of the country, especially whether this is usually before or after wheat harvest. As there is a difference in this respect, it is desirable to ascertain the boundary line between the sections; to know whether it varies according to kind of wheat that is raised, spring or winter, or according to latitude.

It would seem that a thing apparently so easily ascertained, and which has been so often observed, ought to be generally known; but it appears to have been overlooked by those writing in reference to the chinch-bug and its habits.

My personal observations of the habits of the species have been confined to the winter-wheat belt, where it is usually, and so far as I know universally, the case that they migrate after harvest. This fact should therefore be taken advantage of by the farmers within that region, as it affords them an excellent means of destroying this pest.

ABSTAINING FROM THE CULTIVATION OF GRAIN FOR ONE OR TWO SEASONS.

This measure is somewhat fully discussed by Dr. Le Baron in the extract heretofore given from his second report. His suggestion only applies to the small grains and chiefly to spring wheat. But aside from the impossibility of carrying out this plan, I have serious doubts whether it will be of any real advantage if we take into consideration the loss of the crop. That it will be of no permanent benefit I think must be admitted by every one who is acquainted with the habits of the species. However, as remarked by the Prairie Farmer correspondent, whose

words have been already quoted, in order that this remedy be made effectual it would be necessary to transform our land into a desert.

It is unnecessary, therefore, to discuss this remedy.

ROLLING.—Mr. Riley makes the following remarks in reference to this remedy:

"As the mother chinch-bug has to work her way under ground in the spring of the year, in order to get at the roots upon which she proposes to lay her eggs, it becomes evident at once that the looser the soil is at this time of the year the greater the facilities which are offered for the operation. Hence the great advantage of plowing land for spring grain in the preceding autumn, or, if plowed in the spring, rolling it repeatedly with a heavy roller after seeding. And hence the remark frequently made by farmers, that wheat harrowed in upon old corn ground, without any plowing at all, is far less infested by chinch-bug than wheat upon land that has been plowed."

EARLY SOWING.—As Dr. Le Baron has discussed this proposed measure somewhat thoroughly, it is unnecessary for me to advert to it except to add that it might be well for the farmer in the northern portion of the chinch-bug belt to push the line of winter wheat as far northward as possible. By judicious selections it may be possible to obtain varieties which will be adapted to more northern climates than those now in use. There are some objections to this which may possibly outweigh the supposed advantage; one is the greater liability to injury by the Hessian-fly.

So far as corn is concerned, I believe that as a rule which has but few exceptions the sooner it is planted after the spring is fairly opened, and the ground is properly prepared, the better.

The more vigorous the growth of either crop the less will be the injury by the bug; even if they could exist in a damp season when the plants are strong and healthy, the damage occasioned by them would be slight compared to what it is in a dry year when the plants are enfeebled by a lack of moisture. On this account it is desirable that the hardiest varieties, or such as can best withstand drought, should be used.

OTHER REMEDIES.—It has been suggested that it might be of advantage to sow a strip of spring wheat around a field of winter wheat, so that when the bugs have sucked it dry, or as soon as the winter wheat is cut, and before the bugs have commenced to migrate to the corn, the spring wheat may be burned.

Some have tried surrounding other crops with Hungarian grass or millet, hoping to retain the bugs in it; but none of these expedients have proven of sufficient advantage to warrant the trouble and expense. Now and then there has been an exception, but the result has generally been as stated.

Topical remedies, such as the application of lime, salt, tarred sawdust, and other similar substances, will prove, as Dr. Le Baron has well remarked, "labor lost." That it is possible to destroy them by the use

of hot water and certain acrid liquid substances is undoubtedly true, but such remedies can be profitably used only on a small scale, as in the garden. Thorough drenching with water at the proper season, as recommended by Dr. Fitch will also destroy them; but all such remedies are inapplicable to field culture, as the expense would far exceed the value of the crop to be raised.

Remedies for the protection of the corn crop.—Fortunately for the farmer, nature has so arranged it that the summer brood, when compelled to migrate in search of food, either from necessity or preference, move on foot. As they all go together or in bodies when the movement commences, and usually in the same direction, it is apparent that if an obstruction of any kind can be placed in their way so as to retard their progress this will mass them in a comparatively small space and render their destruction much easier than when scattered through the fields. If the obstruction can be made to effectually bar their progress, they will be compelled to seek food elsewhere or perish. Farmers aware of this fact from their observations have had recourse to a number of expedients to accomplish this desired end to save their corn crop, which is the one that chiefly suffers from the migrating hordes.

One of the devices employed is to set up boards edgewise around the field or along the side which the bugs are approaching and besmear them with tar or kerosene. As this plan is described in Dr. Le Baron's notes, already quoted, it is unnecessary to note it farther than to say that although, perhaps, one of the most effectual bars to their progress, the expense and difficulty, in some places, of procuring plank and tar just at the time they are needed will prevent its being extensively adopted.

Another and more common method of stopping their progress is to plow a narrow strip around the field, keep it well pulverized by harrowing and rolling, then plow one or two furrows in this dusty strip. This should be done every day or two, care being taken to keep the strip as thoroughly pulverized as possible, as the bugs cannot travel well through the dust. The philosophy of this plan is, that as the bugs attempt to crawl up the sides of the dusty furrows the loose particles give way, and they roll back to the bottom. If they accumulate in the furrows a log or stone must be drawn through them so as to crush and destroy them. As it is always, probably without exception, dry weather when they migrate and the soil dry, it is not difficult to keep the plowed strip pulverized if the clods are well crushed at first by rolling with a heavy roller where the soil is clayey.

Ditching is sometimes resorted to, but in this case care should be taken to have the side next the field perpendicular, and it would be well to drag a stone, log, or bundle of brush through it as soon as made, so as to rub the sides and somewhat pulverize them or render them dusty.

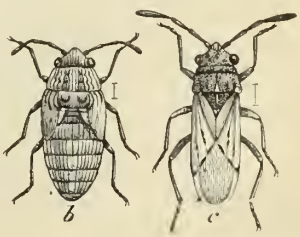
As they generally confine their operations for a time to the first few rows of corn of the field they attack, it is possible to destroy a large number of them by applying hot water, and this has in some instances

been successfully practiced, but the labor and expense are generally too great to justify it.

REMARKS.—Clean farming is the best under all circumstances, and, if adopted as a rule, will tend largely toward preventing the increase not only of chinch-bugs, but of all other injurious insects that trouble the farmer. But one of the best methods of preventing their increase is diversified farming. Massing crops in immense bodies and cultivating the same thing year after year on the same ground, as is so often done, necessarily tends to increase the insects that feed on these crops. An increase in one locality of any one plant brings a proportional increase of its insect enemies as a direct effect, and these are increased in a geometrical ratio if the plant is allowed to occupy the same locality for a number of seasons in succession. The only offset in this case is a like increase of the peculiar parasites that prey upon these insects, but in the case of the chinch-bug nature has favored man with no such friends, as it has no true parasite. So long as this violation of natural laws and, I might say, of the true theory of the farmer's profession is continued, so long will it be necessary to war with increasing hosts of insect foes. Enlarging farms and increasing crops will of necessity bring these evils; reverse the system, divide the farms, and diversify the farming, and it will be far less difficult for the farmers to cope with their insect foes. The disposition in our country, especially in the West and South, to obtain and operate large farms by machinery, is one of the evils of our agricultural system. It is to our interest as a nation to multiply farms, to divide the land into as small parcels as possible, to draw the population from the cities into the rural districts, instead of just the reverse, as is the effect of the present system. Small farms and diversified farming is one of the best means not only of counteracting the numerous insect foes with which the farmers have to contend, but also to alleviate or prevent a number of other evils which society has to suffer. But I fear it will be more difficult to bring about this state of things than even to put into operation Dr. LeBaron's suggestion.

Before closing, I would call the attention of those agriculturists into whose hands this Bulletin may fall to the fact that there are other species of insects which are sometimes mistaken for the chinch-bug. These are generally of the same order or sub-order as that to which the chinch-bug belongs, viz: *Heteroptera*. The one which bears the strongest resemblance to this noted pest is the false chinch-bug (*Nysius destructor* Riley, Fig. 9). This species appears to have fully as wide a range as the true chinch-bug and over the same area. In the perfect state it is shaped much like the true chinch-bug, and bears a somewhat strong general resemblance to it, though differing materially when closely examined. It varies in length from one-tenth to one-eighth of an inch to the tips of the wings, is of a gray-

FIG. 9.



False Chinch-bug.—*b*, pupa; *c*, mature bug.

ish-brown color, the antennæ pale, with the fourth joint enlarged and as long as the third; the elytra or upper wings pale, and usually more or less tinged with dirty yellow on the basal portion; the legs pale yellowish, with brownish thighs. Like the true bug, it hibernates in the perfect state. In the summer it is frequently found on various wild flowers and small fruits. It is also fond of purslane.

Fig. 10.

Ash-gray Leaf-bug.

A second species, the ash-gray leaf-bug (*Piesma cinerea* Say, Fig. 10), according to Mr. Riley, is also often mistaken for the chinch-bug. It is of a greenish-gray color, about one-sixth of an inch long, and is flatter and broader than the true pest.

As one object of this bulletin is to call attention to this injurious insect and gather facts for a further report, it is hoped that any one into whose hands a copy may fall who has information to communicate, will do so by addressing the writer at *Carbondale, Illinois.*

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Yankton
Omaha
Cheyenne
Denver
Taos
Santa Fé
Salt Lake Cy.
Humboldt City
Humboldt Sink
San Francisco
San Diego
Sacramento R.
San Joaquin R.
Virginia City
Fort Benton
Portland
Lake Pend d' Oreille
Lake Coeur d' Alene
Salmon R.
Snake R.
Yellow Stone R.
Stone R.
Big Horn R.
Powder R.
Yellowstone Lake
Missouri River
Milk R.
Mouse R.
Pembina R.
Red R. of the North
Ft. Garry
LAKE OF THE WOODS
L. Sal.
Willamette R.
Humboldt R.
Green R.
Grand R.
Rio Puerco
Rio Grande
Pecos R.
Colorado R.
Gila R.
Platte R.
South Platte R.
North Platte R.
Cheyenne R.
Missouri R.
Mississippi R.
Illinois R.
Wabash R.
Ohio R.
Kanawha R.
Kentucky R.
Tennessee R.
Cumberland R.
Red River
Trinity R.
Brazos R.
Colorado R.
Rio Grande
Arkansas R.
Canadian R.
Kansas R.